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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/581,256	05/31/2006	Mitsuhiro Okune	2006_0772A	1821

52349 7590 11/24/2009

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EXAMINER	
DAHIMENE, MAHMOUD	

ART UNIT	PAPER NUMBER
1792	

MAIL DATE	DELIVERY MODE
11/24/2009	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/581,256	OKUNE ET AL.	
	Examiner	Art Unit	
	MAHMOUD DAHIMENE	1792	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *06 August 2009*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *20,21,24-27 and 30-34* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *20,21,24-27 and 30-34* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

3. Claims 20-21, 24-27, 30-31, 33-34 are rejected under 35 U.S.C. 103(a) as being unpatentable over McReynolds (US 6,191,043) in view of Collins et al. (EP 0 472 941 A2) and Nagata et al. (Japanese Journal of Applied Physics, Vol. 28, No. 11, November, 1989, pp. 2368-2371) as evidenced by Tzeng et al. (J. Electrochem. Soc. Vol. 134, No. 9, September 1987, pp. 2304-2309).

Regarding claims 20-21, 24-25, 33-34 McReynolds teaches SF.sub.6 /O.sub.2 /He plasma etch chemistry is conventionally used for etching silicon (column 1, line 34). On the top surface of the chamber 304, there is disposed a quartz window 306, which serves as a transparent medium to allow RF energy to enter the chamber (figure 3). McReynolds cites "Other gases that may be substituted for SF.sub.6 include C.sub.4 F.sub.8, CF.sub.4, NF.sub.3, and CHF.sub.3." (column 5, line 19).

It is noted that McReynolds discloses RF power for generating the plasma, and is silent about a frequency equal to or more than 27 MHz.

Collins teaches frequencies of about 50 to 800 MHz are desirable for generating plasmas, including silicon etching plasmas, because they allow to avoid damage to structures on the wafer (abstract)(column 4, line 18).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process McReynolds to include the frequencies of Collins because frequencies of about 50 to 800 MHz are known to be desirable for generating plasmas including silicon etching plasmas.

One of ordinary skill in the art would have been motivated to modify the process McReynolds to include the frequencies of Collins in order to lower any damage to structures on the wafer.

It is noted that McReynolds is silent about a specific volumetric flow rate of the helium (He) gas introduced into the treatment chamber is equal to or more than 80% of a total volumetric flow rate of the etching gas. However, McReynolds discloses "The addition of argon also played a contributory role in enhancing the ion bombardment."

(column 6, line 25), "An important feature of this inventive method of etching ultra deep openings is the inclusion of an inert bombardment-enhancing gas such as argon or xenon. It is believed that the addition of this inert bombardment-enhancing gas might possibly play a role in eliminating the undercutting of the hard mask, which in turn helps in controlling the sidewall profile. Adding a heavy inert gas such as argon to the total gas flow is also believed to contribute to the improvement of the RIE lag problem. RIE lag is the etch rate difference between different openings that are being etched. Usually RIE lag occurs in openings having different feature sizes, but in some cases, RIE lag occurs in features of the same size. The latter situation is believed to occur when there are not enough reactive ions in the openings to continue the etching. The addition of an inert bombardment-enhancing gas to the total flow alleviates that problem by enhancing ion bombardment in the etching process, thereby reducing an etch stop condition while not affecting the polymer formation and profile." (column 6, line 35). McReynolds clearly suggests that the addition of heavy ion bombardment inert gas such as Argon (or Xenon) to the total gas flow allows controlling the sidewall profile, eliminating the undercutting of the hard mask and improvement of the RIE lag problem, This in turn clearly suggest that using the same etching gases, without Argon, will effectively etch silicon without the added benefits of the contribution of Argon gas.

In table 2 of McReynolds, removing Argon gas form the etching gas chemistry will result in a volumetric flow rate of the helium (He) gas introduced into the treatment chamber is equal to 81.63%, which is more than 80% of a total volumetric flow rate of the etching gas. ([400/(50+20+10+400)] = 0.8163).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made willing to accept less control of the sidewall profile, and less improvement of the RIE lag problem, to modify the process of McReynolds to remove the Argon gas from the etching chemistry because McReynolds clearly suggest that using the same etching gases, without Argon, will effectively etch silicon without the added benefits of the contribution of Argon gas.

One of ordinary skill in the art would have been motivated to remove the Argon gas from the etching chemistry of McReynolds when low profile control and RIE lag are acceptable for the specific silicon etch.

It is also noted that McReynolds uses oxygen in the etching gas, and McReynolds is silent about an etching gas that does not contain oxygen (O_2) gas.

Nagata teaches that one of the major role of oxygen in a NF3 (or CF4) mixture plasmas is control of the etching selectivity of silicon to SiO2 (figures 4 and 5)., particularly, in figure 5, Nagata shows that the etch rate of SiO2 increases monotonically as the O2 in NF3 (%) decrease from 90% to 0%.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of McReynolds by completely removing the oxygen in the plasma when selectivity to SiO2 (silicon dioxide) is not an issue (when no oxide hard-mask is used) at 400 degree C.

One of ordinary skill in the art would have been motivated to modify the process of McReynolds by completely removing the oxygen in the plasma when selectivity to

SiO2 (silicon dioxide) is not an issue in order to obtain the highest silicon etch rate at 400 degree C.

As to claim 21, it is noted McReynolds is silent about SF6 without oxygen, however, as discussed above, the claim is rejected for the same reason as above claim 20 as evidenced by Tzeng who teaches the same trend exists for SF6 plasma and the role of oxygen (page 2304)(Figures 3 and 6).

Regarding claims 26, 27 McReynolds provides etching parameters in Table 2, where Helium gas flow is used between 100 to 400 sccm. When considered with relative to the range of the flow of the other SF_6, Cl_2, Ar gases, the He and Cl2 of McReynolds gas flows overlap the ranges claimed by the applicant in claims 27.

As to claims 30-31, It is prima facie obvious to combine two compositions each of which is taught by the prior art to be useful for the same purpose, in order to form a third composition to be used for the very same purpose. The idea of combining them flows logically from their having been individually taught in the prior art, since McReynolds teaches Other gases that may be substituted for SF.sub.6 include C.sub.4 F.sub.8, CF.sub.4, NF.sub.3, and CHF.sub.3.

As to claim 35, McReynolds teaches Other gases that may be substituted for SF.sub.6 include C.sub.4 F.sub.8, CF.sub.4, NF.sub.3, and CHF.sub.3. Since it is prima facie obvious to combine two compositions each of which is taught by the prior art to be useful for the same purpose, in order to form a third composition to be used for the very same purpose, then, for instance combining SF.sub.6 and CF.sub.4 (or C.sub.4

F.sub.8, NF.sub.3, and CHF.sub.3 all of which are polymer forming gases) is obvious since McReynolds teaches the two gases accomplish equivalent function as far as etching silicon. Since the applicant uses the open language expression "method comprising" which is interpreted by the examiner as more etching gases are comprised, it is hard, if not impossible to predict what removing the (CF_4) gas will do to the etching rate since there is no basis for comparison, namely the (potentially used) other gases have not been specified by applicant in the open language claims. In the case of McReynolds removing the (CF_4) gas will definitely reduce the etching rate when (CF_4) gas (in case CF_4 is substituted for SF6) is the only gas relied on to deliver the fluorine species for etching the layer since no other etching gas remains other than O2 and Helium which lack the ability of providing fluorine.

Claim Rejections - 35 USC § 103

Claim 32 is rejected under 35 U.S.C. 103(a) as being unpatentable over McReynolds (US 6,191,043) in view of Collins et al. (EP 0 472 941 A2) and Nagata et al. (Japanese Journal of Applied Physics, Vol. 28, No. 11, November, 1989, pp. 2368-2371) as evidenced by Tzeng et al. (J. Electrochem. Soc. Vol. 134, No. 9, September 1987, pp. 2304-2309) as applied to claims 20-31 above, and further in view of Okumura (US 2003/0034542).

McReynolds teaches Other gases that may be substituted for SF.sub.6 include C.sub.4 F.sub.8, CF.sub.4, NF.sub.3, and CHF.sub.3. Since it is prima facie obvious to combine two compositions each of which is taught by the prior art to be useful for the

same purpose, in order to form a third composition to be used for the very same purpose, then, for instance combining SF.sub.6 and CF.sub.4 (or C.sub.4 F.sub.8, NF.sub.3, and CHF.sub.3 all of which are polymer forming gases) is obvious since McReynolds teaches the two gases accomplish equivalent function as far as etching silicon.

McReynolds teaches a step (first step) using SF.sub.6 /O.sub.2 /He plasma etch chemistry is conventionally used for etching silicon (column 1, line 34)

It is noted that McReynolds is silent about a second step comprising SF.sub.6 and CF.sub.4 as required by applicant's claim 32.

Okumura discloses "Next, as shown in FIG. 11A, the photoresist mask 113 is removed. Next, as shown in FIG. 11B, with the silicon oxide layer 112 used as a mask, RIE is performed using SF.sub.6 and CF.sub.4 to selectively etch out the silicon plate 16a" (paragraph 01 013). The reference of Okumura is relied on only to teach that silicon is selectively etched using SF.sub.6 and CF.sub.4, it is not relied on to teach device manufacturing.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of McReynolds to split the etching process into two steps because McReynolds teaches a step (first step) using SF.sub.6 /O.sub.2 /He plasma etch chemistry is conventionally used for etching silicon and combining SF.sub.6 and CF.sub.4 (or C.sub.4 F.sub.8, NF.sub.3, and CHF.sub.3 all of which are polymer forming gases) is obvious since McReynolds teaches the two gases accomplish equivalent function as far as etching silicon.

One of ordinary skill in the art would have been motivated to split the etching process of McReynolds into two steps when selectivity to an underlayer silicon oxide is required. One of ordinary skill in the art would have been motivated to select SF.sub.6 and CF.sub.4 as the second step when the first etch step does not require selectivity in the etching, but the second step which exposes an underlayer requires selectivity to the underlayer.

Response to Arguments

Applicant's arguments, filed 8/6/2009, with respect to the rejection(s) of all pending claim(s) have been fully considered and are persuasive in view of the new amendments to claim 20 requiring no oxygen is used. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made in view of Nagata et al. (Japanese Journal of Applied Physics, Vol. 28, No. 11, November, 1989, pp. 2368-2371) as evidenced by Tzeng et al. (J. Electrochem. Soc. Vol. 134, No. 9, September 1987, pp. 2304-2309).

Conclusion

4. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MAHMOUD DAHIMENE whose telephone number is (571)272-2410. The examiner can normally be reached on week days from 8:00 AM. to 5:00 PM..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on (571) 272-1465. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/M. D./
Examiner, Art Unit 1792

/Nadine G Norton/

Supervisory Patent Examiner, Art Unit 1792